REMARKS

Claims 4-8 stand objected to under 37 CFR 1.75(c) as being of improper multiple dependent form. These claims have been amended pursuant to the Examiner's remarks to over come this objection.

Claims 17 and 21 stand objected to for grammatical informalities. These claims have been amended consistent with the Examiner's remarks to overcome these objections.

Claims 3, 19, 20, 22, 23 and 26 stand rejected under 35 USC 112 as being indefinite. These claims have been amended to overcome this § 112 rejection. Claims 19, 20, 22, 23 and 26 stand rejected under 35 USC 101 because of a recitation of a "use" without setting forth the steps involved in a process. These claims have been amended to overcome this § 101 rejection.

Claim 1 stands rejected under 35 USC 103(a) as obvious in view of Takahashi (US 5,955,753) when read with Lambeth (US 4,826,312) and Arques (US 4,985,619). This rejection is TRAVERSED for the reasons recited below.

Claims 1-9, 14, 16, 17, 19-23 and 25-27 stand rejected under 35 USC 103(a) as being obvious in view of Schwarte (WO 98/10255) when read with Lambeth. This rejection is TRAVERSED for the reasons recited below.

Claims 10-12 stand rejected under 35 USC 103(a) as being obvious in view of Schwarte when read with Lambeth and Takahashi. This rejection is TRAVERSED for the reasons recited below.

Claim 13 stands rejected under 35 USC 103(a) as being obvious in view of Schwarte when read with Labmbeth, Takahashi and Wilder (US 5,262,871). This rejection is TRAVERSED for the reasons recited below.

Claims 15, 18, and 24 stand rejected under 35 USC 103(a) as being obvious in view of Schwarte when read with Lambeth, and Wilwerding (US 4,812,640) and Matsumoto (US 5,420,634). This rejection is TRAVERSED for the reasons set forth below.

It is well settled law that the claims of an application are to be interpreted in light of the specification and drawings. *Markman v. Westview Instruments, Inc.*, 116 S Ct 1384 (1996).

The Examiner is reminded that an applicant is permitted to be his own lexicographer and that the meaning of his words are to be interpreted in light of his disclosure.

It is also well settled law that any technical terms not interpreted in light of the specification and drawings are to be taken in their ordinary sense, as defined in a Technical Dictionary or other defining publication.

The Examiner is required to set forth in his Office Action: (A) the relevant teachings of the prior art relied upon, including making reference to the relevant column of page number(s) and the line number(s) where appropriate; (B) the difference or differences in the claim over the applied reference(s); (C) the proposed modification of the applied reference(s) necessary to arrive at the claimed subject matter; and (D) an explanation why one of ordinary skill in the art at the time the invention was made would have been motivated to make the proposed modification. See MPEP 706.02(j). The Examiner has failed to adequately provide all four phases of this information. The MPEP is quite clear that all four phases (items (A) through (D)) must be made. The Examiner failed to address why one of ordinary skill in the art would at the time of the invention have been motivated to make the proposed modification. In failing to make the analysis phase (D) applicant believes the Examiner has misunderstood the structure and operation of the prior art. Applicant's technical support will follow below.

In order to establish a *prima facie* case of obviousness the following three basic criteria must be met: 1) there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art to combine

the specific reference(s) teachings; 2) there must be a reasonable expectation of success in combining the specific reference(s) teachings; and 3) the prior reference (or references when combined) must teach or suggest all of the claim limitations. See MPEP 706.02. The teachings or "suggestion to combine" and the "reasonable expectation of success" must both be found in the prior art and not based upon the applicant's disclosure. *In re Vaeck*, 947 F2d 488, 20 USPQ2d 1438 (Fed Cir 1991). The initial burden is on the Examiner to provide support for a *prima facie* case. *Ex parte Clapp*, 277 USPQ 972, 973 (Bd. Pat. App. & Inter. 1985).

The Examiner has not met his burden in support of the outstanding 35 USC 103(a) rejections.

The rejections under 35 USC § 103 and based on the prior art cannot be sustained and are improper. It appears that the Examiner has miss-read the present invention and its differences from the prior art. The present invention has nothing to do with photosensitivity in the ordinary meaning as taught by the prior art. Photosensitivity, as referred to in connection with the present invention is only a vehicle for performing a mixing process which occurs between modulated electromagnetic waves and a modulating electrical field applied to the corresponding gates of the mixing device.

The purpose of such a photonic mixing element, in the present invention, is not to gain electrical charges, currents or voltages in response to, and in correspondence with, light impinging on the photonic mixing element as shown in the prior art. To the contrary, in the present invention, the photonic mixing elements function is only to be responsive to any correlation between a modulation of impinging electromagnetic waves and the modulation of an electromagnetic field applied to the gates. In other words, the present invention, when used in place of an ordinary photosensitive device as disclosed by any of the documents of Takahashi (US 5,955,753), Lambeth (US 4,826,312) and Arques (US 4,985,619), would be completely

blind (inoperative), i.e. would not give the slightest output signal even under the brightest illumination conditions under which the devices of prior art would be operative.

The present discussion addresses devices (i.e., those taught by the prior art), which are only capable of being sensitive to the optical range of electromagnetic waves. The present invention, of course, is capable of being sensitive (operative) over the whole available range of electromagnetic waves from X-rays to the far-infrared and microwave ranges.

It is true that Takahashi shows poly-silicon layers 19 acting as photo gates and also an N+ region 21 which may be considered as an accumulation gate. However, in contrast to the remark made by the Examiner in paragraph 12 of the outstanding Office Action, the Takahashi photo gates are definitely <u>not</u> "modulation photo gates". Any voltages which may be applied to either the Takahashi photo gates 19 and further control gates 20 <u>are just</u> control voltages which serve as confining and switching means in order to let the charges generated under the photo gates be collected and then be transferred to the N+ region 21, and from there to an accumulation capacitor, which means that the N+ region 21 <u>is the</u> accumulation gate. The Takahashi poly-silicon layers 20 thus only serve as control gates controlling the flow of charges from the photo gate region to the accumulation gate 21 and there is a single accumulation gate associated to each pair of photo gates 19; wherein any other accumulation gates would be just the same and would not be distinguished from each other. All the accumulation gates (regions N+ 21) in Takahashi are operating and are connected in the same way (note, only one of a plurality of accumulation gates 21 is shown in Takahashi's Fig. 2). The various control pulses which are applied to the photo gates 19 and control gates 20 only serve for the purpose to collect charges under the photo gates 19 for a well-defined time period, then shift those charges towards the accumulation gate 21 and from there to an accumulation capacitor, wherein these operations are repeated on a time scale in the order of milliseconds, corresponding to an ordinary frame repetition rate. The amount of charges generated under each photo gate during

said given time period is considered to represent the amount of light impinging on said area during said given period (which in turn may then be displayed in proportion on a screen).

The additional references Lambeth and Arques are focusing on other aspects and details of photosensitive devices or diodes, wherein the same basic operations and functions would occur on a similar time scale as Takahashi.

The main purpose of any further developments in the field (of the technology of Takahashi, Lambeth and Arques) is seeking to increase the sensitivity, i. e. increasing the amount of collected charges generated by a given amount of light, to reduce the time period for generating and transferring the charges and to clear the gates as quick as possible by applying appropriate control voltages in order to start the collecting period. This may further result in higher frame rates, smaller pixel areas and thus improved resolution. None of these objects is the focus of the present invention.

In contrast to the prior art, the present invention comprises at least two different sets of accumulation gates which are read out in a continuous manner without any defined collecting and shifting periods, wherein the two sets of accumulation gates of the present invention are distinguished by their different connection, wherein every other accumulation gate belongs to every other set and the charges or voltages derived from these two different sets of accumulation gates are combined such that the difference between the two signals derived from the accumulation gates is obtained. Moreover, this difference is obtained in a continuous manner and not controlled by any switching pulses applied to control gates such as in Takahashi (see Takahashi Figs.2 - 4, reference numerals 20 and the potentials TXO and TXe).

In the present invention, two different sets of accumulation gates are each connected to each one of the two inputs of a differential amplifier (or one of the signals is inverted and then the inverted signals of one set is added to the signal of the other set), so that actually the

difference between the signals from the two sets of accumulation gates is obtained (see applicant's Fig. 3).

Contrast this to the prior art where there is taught a summing of the signals form accumulation gates.

The operation of the present invention results in the effect that, once a modulation voltage is applied to the modulation photo gates, the difference between the signals obtained from the two sets of accumulation gates is just zero (at least if the integration time for determining the difference is substantially larger than the time period for the modulation frequency), even though a lot of charges will be generated due to the exposure of the device to corresponding electromagnetic waves (in particular light). In particular, the present invention is designed for modulation frequencies well above 10 kHz and in particular even for the GHz region, which means that the pulses occurring on the modulation photo gates in an alternating manner are occurring on a time scale of microseconds and even nanoseconds. Without the strip structure, this results in the measuring of continuous signals and not in a stepwise manner. On the other hand, this results in the fact that the sensitivity of the present invention, when compared to ordinary photodiodes of the prior art, is extremely poor and in the ideal case is simply zero under ordinary illumination.

<u>Only if</u> the illumination (i.e. the intensity of the impinging electromagnetic waves) is modulated with a modulation frequency that has a well-defined relationship (i. e. correlation in the mathematical sense) to the modulation frequency of the modulation photo gates, the difference of the signals from the different sets of accumulation gates is not zero and results in a combined signal which corresponds to the mixing or correlation function of the modulated electromagnetic waves and electric modulation frequency of the modulation photo gates. This correlation function is the physical property that is measured by a mixing device of the present invention.

The principally different connection and operation of the individual gates for the present invention (i.e. different sets of accumulation gates which are distinguished by the fact that they are connected to different inputs or to any means combining the signals from the two different sets in order to obtain the difference therebetween), the completely different time scale of the modulation frequency (when compared to control pulses of the prior art) and the continuous readout which is not related to any frame renewal rate, should be now apparent to the Examiner. Furthermore, the examiner should understand that, notwithstanding some of the apparent similarities in structure between the present invention the prior art, the underlying physical principles and operation of the individual gates and areas of such a mixing device is completely different from ordinary and even any sophisticated photosensors and photosensitive devices disclosed in any of the cited prior art, except for Schwarte, wherein it should be noted that the Schwarte reference, of course, belongs of the same inventor as the present invention. Because of these differences, one of ordinary skill would not look to combine, successfully, the teachings of the other prior art with the Schwarte reference.

As opposed to sensitivity and quick response (in terms of renewal rates) which are relevant for ordinary photosensitive devices, a feature of the present invention is a physical property called "contrast", which is given by the difference of the voltages obtained from the different sets of accumulation gates over the sum of the voltages obtained at these two different sets of accumulation gates, which (sum) is just due to the modulated portion of the impinging electromagnetic waves.

In particular, in order to understand the applicability of the phase-sensitive measuring properties and the signal processing properties of the present mixing device (which, for instance, allows measurement of distances, i.e. results in a 3D-vision (when further combined with sensitivity measurements or allows optical data transmission and conversion), it is

important to maintain the contrast at ever increasing frequencies, i.e. the high MHz and even the GHz regions.

For this purpose, applicant discovered his present structure of long narrow parallel strips that "group-wise" form a PMD pixel is most favorable. Considering the above, it should now be clear that one of ordinary skill would not look to ordinary photosensitive devices such as shown by Lambeth, because obtaining and maintaining a sufficient contrast as defined above on basis of a continuous read out of two different sets of accumulation gates under a high frequency modulation by arranging the said gates in a strip structure is nothing which was shown or suggested by Lambeth or nor by any of the other cited references.

Similar to Takahashi, the Lambeth device operates in a manner where charges are first collected under a photo gate and are then repeatedly transferred to a transfer gate, wherein the signals are further processed in order to obtain signals for an output pixel which corresponds to the illumination of the input pixel. This occurs at a repetition rate which allows the recording, transmission and outputting of moving pictures, which frequency is considerably different from that contemplated by the present invention.

In contrast, with the present invention, the readout of the accumulation gates occurs in a continuous manner and the photo gates are modulated at high frequencies. Thus, anything that may be reasonable to accelerate the "fill-and-spill" process as suggested by Lambeth, gives not the slightest hint regarding improvements or maintaining the contrast as defined above at ever-increasing frequencies in the MHz region of the present invention.

Referring again to the Schwarte reference (belonging to the same inventor and applicant as the present invention), there is shown, in principle, a predecessor structure to the improvement of the present invention. But of course without any showing or suggestion of the strip structure, nor a need for same.

In the present invention, the designing of the pixel with optoelectronic stripes, by e.g. providing 30 narrow stripes instead of a larger gate area as shown in the Schwarte reference, improves the time of flight resolution, e.g. for a 3D-camera, by a factor of 1000. This is a surprising effect that could never be predicted from any prior art document. If one were start from the knowledge of the function of the present invention, it is clear that nothing can be learned from ordinary photosensitive devices of the prior art. It should be quite evident that one of ordinary skill would not combine the teaching of Takahashi, Lambeth or Arques with the Schwarte reference to produce an operative device. Therefore, one of ordinary skill would not look to make the combinations suggested by the Examiner. They simply would not work.

Therefore, the claims as previously examined distinguish over the cited prior art. Nevertheless, in order to even better distinguish over the cited prior art, the following limitation has herein been added to independent claims 1 and 21.

"... wherein the accumulation gates of a (PMD-) pixel are divided into at least two groups of accumulation gates, each group being connected to a common readout line and means are provided for determining the difference of the signals received from the readout lines of the said at least two groups of accumulation gates."

The meaning of these features should be evident from Fig. 3 when read with the corresponding description, showing for instance on the left-hand side two different groups of accumulation gates. These gates are connected to the readout line K_{I}, with only one accumulation gate, 4, forming the respective group and to others, denoted as 5, being connected to the readout line K_{+I} forming the second group. The same occurs on the right-hand side with respect to the respective lines K_{+Q} and K_{-Q}. As shown Fig. 3 of the present invention, the respective figure is only a section of a <u>larger</u> device, so that in general a group of accumulation gates 4 would consist of more than one or two accumulation gates (even though such a small number should not be excluded). Further, the index "I" and "Q" refers to the in-

phase and the quadrature component, which means that there is a further shift in the phase between the two modulation voltages applied to the right-hand portion of Fig. 3, when compared to the left-hand portion (indicated as U_m and U_{mQ}, respectively). Further, block A in Fig. 3 shows among others an output UΔ1 and UΔQ, respectively, referring to determining the difference between the two respective input lines as described above. All of the additional claimed features are clearly visible in Fig. 3.

For the reasons stated above, the stand 35 USC 103 (a) rejections should all be withdrawn with respect to the independent claims and each claim depending therefrom For the additional reasons stated above, the claims as now amended further distinguish the present invention over the combination of prior art.

It is requested that the application be re-examined with the claims as presented herein and be passed to issue with these claims.

Respectfully submitted,
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Date: Mar 22, 2004

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